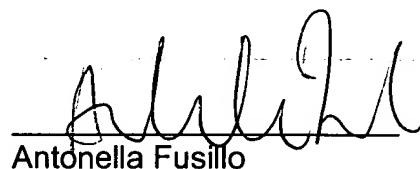


## VERIFICATION OF A TRANSLATION

I, Antonella Fusillo, resident of the United States, residing at 28-32 45<sup>th</sup> Street, # 2F, Astoria, N.Y. 11103, depose and state that:

1. I am familiar with the English and German languages.
2. I have read the attached German Search report regarding German patent application no. 198 08 145.6.
3. The hereto attached English language text is an accurate translation thereof.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.



Antonella Fusillo

Date: May 17, 2000

1    PROCESS FOR INJECTION MOLDING, INJECTION MOLD AND INJECTION  
2    MOLDING DEVICE, AS WELL AS PROCESS FOR FILLING A MAIN  
3    EXTRUDER FROM A SECONDARY EXTRUDER

4    **Background of The Invention**

5    The invention relates to a process for injection molding of injection molded  
6    parts from plasticizeable material, wherein a first plasticizeable material is  
7    injected into the hollow of an injection mold, and subsequently another  
8    plasticized material is injected into the hollow, as well as to an injection mold and  
9    an injection molding device with a plasticizer unit and an injection unit.

10

11    Processes of this type are known under the term "mono-sandwich  
12    process" and "two-component process".

13

14    The mono-sandwich process includes initially injecting into an injection  
15    mold, for example, a particularly pure plasticized material which hardens on the  
16    wall surface of the injection mold, and subsequently injecting a filler which forms  
17    the core of the injection molded part and generally contains inferior materials.  
18    This makes it possible, at low materials costs, in particular when using recycled  
19    materials, to produce injection molded parts with surfaces that are formed  
20    entirely from high-grade materials.

21

22    In order to produce injection molded parts with elements of various  
23    materials, the two-component process is used which includes various injection

1 units for introducing plasticizeable materials into the injection mold at various  
2 locations, so that, for example, a toothbrush can be made with areas of hard  
3 plastic and a flexible intermediate area of softer plastic. The two-component  
4 process requires, however, a very complicated injection molding device so that  
5 the production process becomes relatively expensive.

*A* 6 SUMMARY OF THE INVENTION

7 In view of the known prior art, it is an object of the invention to propose a  
8 simple injection molding process for making injection molded parts from various  
9 materials.

10

11 This object is attained in accordance with a generic process by so  
12 introducing a first plasticized material into the hollow as to wet only a partial area  
13 of the wall surface of the hollow, and by subsequently so introducing another  
14 plasticized material into the hollow as to wet at least a part of the remaining area  
15 of the wall surface of the hollow.

16

17 According to the process of the invention, part of the hollow is kept initially  
18 inaccessible, or such a small quantity of the first plasticizeable material is  
19 injected that only part of the wall surface of the hollow is wetted. Subsequently at  
20 least one further material is introduced into the then cleared remaining hollow to  
21 harden in the remaining area of the wall surface of the hollow, so that the finished  
22 injection molded part comprises an exterior surface made of various materials.

23

1        The process allows the use of a modified conventional mono-sandwich  
2    injection molding machine, whereby, in contrast to current conventional  
3    processes, particular regard is directed to the fact that the second material is not  
4    completely enveloped by the first material. In particular, when the second  
5    material is also a high-grade material, the process according to the invention  
6    permits the production of injection molded parts from various materials which  
7    cannot be distinguished from conventional injection molded parts made by the  
8    two-component process.

9  
10       According to a preferred variation, the first plasticized material and at least  
11    one other plasticized material are injected into the hollow through the same  
12    opening. A single opening in the injection mold for various materials results in  
13    lower production costs for the injection molding device and permits a simple  
14    process control as the individual materials are injected in succession into the  
15    injection mold at the same location. Exact dosage and filling times realize  
16    outstanding production results at most different injection molded parts.

17  
18       Since the transition area of the injection molded part between the partial  
19    area and the remaining area of the wall surface oftentimes forms in practice an  
20    irregular or blurred line, it is proposed to introduce only so much first material into  
21    the injection mold that after injection of the other material, the first material  
22    extends up to a shoulder in the hollow between the partial area and the  
23    remaining area. The shoulder may be a random edge which preferably projects

1 from the wall surface into the interior of the hollow and forms a barrier against  
2 continuous flow of the first plasticized material into the area of the shoulder.

3

4 As an alternative, or in addition to, the described process, after injection of  
5 the first material a slide gate can be moved to clear at least part of the remaining  
6 area. The term "slide gate" will refer to either a valve-like element which clears a  
7 channel to a partial area of the hollow in the injection mold. This allows directing  
8 the flow of the plasticized material from a single injection point via various  
9 channels into various partial areas of the hollow. However, the slide gate can  
10 also be designed as a plunger which, when pushed into a partial area of the  
11 hollow in the injection mold, covers a partial area of the wall surface of the  
12 hollow. When the slide gate is retracted, at least part of the remaining area of the  
13 wall surface of the hollow is cleared, so that the other plasticized material wets  
14 the wall surface of the hollow in this area.

15

16 Beyond the use of various plasticizable materials, hollow injection  
17 molded parts can also be produced when a gas space is formed in the injection  
18 mold during the injection molding process. Such a gas space is realized by  
19 injecting a gas during the injection molding process. Cavities may also be formed  
20 in a way that a material quantity is stretched into an empty space of the hollow  
21 (injection blow molding) to thereby allow cost-efficient production of  
22 two-component injection blow molded parts which contain a hollow. The hollow  
23 may remain under constant gas pressure.

1        A great number of particularly advantageous applications can be  
2 implemented when one plasticized material is a relatively soft or rubber-like  
3 material, and at least one other plasticized material is a relatively hard material.  
4 Whereas the soft or rubber-like material can assume the function of a seal, a tire  
5 or a handle, the relatively hard material serves for the creation of a solid base  
6 body.

7

8        Particular effects can also be realized when the plasticizeable materials  
9 exhibit at least two different colors or are transparent. While the various colors  
10 create optical effects, it is also possible to produce injection molded parts with  
11 colored and transparent areas which for example can be used as a cover with a  
12 transparent window. In particular, transparent injection molded parts, which are  
13 dyed in partial areas to avoid transparency, can be realized by the described  
14 process in a particularly cost-efficient manner.

15

16        In addition, it is advantageous for various applications when at least one  
17 plasticized material includes gas pockets. Gas pockets reduce weight and  
18 material use and may offer other specific advantages, depending on the purpose  
19 of use.

20

21        For example, to use recycling particles, it is proposed that at least one  
22 plasticized material includes pockets of another component. Thus, it is possible  
23 to admix, for example, elastomeric recycling particles to a soft material, to adjust

1 the hardness of the material.

2

3 The above-described process is also capable to combine a biodegradable  
4 material with other materials, in particular with other biodegradable materials. In  
5 this case, a material mixture can be realized, on the one hand, and the various  
6 materials can be injected also as first and second materials, on the other hand.

7 This combination opens up completely new options as the biodegradable  
8 material can be enveloped, for example, by a protective layer. In particular, this  
9 protective layer can be made resistant over a period or under certain  
10 circumstances. For example, material that can be degraded by water may be  
11 enveloped by a layer that can be degraded by microorganisms or by UV light,  
12 thereby realizing a water-resistant part which still can be degraded rapidly after  
13 degrading the outer layer. It will be understood that the combination of a  
14 biodegradable material is advantageous per se.

15

16 Especially suitable for carrying out the process according to the invention  
17 is an injection mold which has at least one sensor disposed at the transition  
18 between the partial area and the remaining area of the wall surface of the hollow  
19 in the injection mold. Such sensors permit, for example by means of pressure  
20 gauges, temperature gauges or ultrasound measuring devices, to ascertain when  
21 a particular plasticized material reaches the location on the wall surface where  
22 the sensor is located. In this manner, the injection process can be accurately  
23 monitored and controlled.

1        In particular, it is possible to arrange such a sensor in an ejection bore of  
2    the mold. For example, the sensor may be an ultrasonic sensor for use as quality  
3    assurance. By utilizing an ejection bore, the sensor can easily be attached  
4    because suitable ejection bores are provided anyway and the provision of only a  
5    further respective bore is required. Also, an existing bore, in particular when  
6    existing molds are involved, can be used.

7

8        It will be understood that any kind of bore may be referred to in the  
9    ejection block so long as it reaches the workpiece. The bore may be closed on  
10   the side of the mold. Still it is possible to very easily position a sensor in  
11   immediate proximity of the workpiece by means of this bore.

12

13        It is advantageous to provide an injection molding device, which is  
14   especially useful for the process according to the invention, with a shoulder at the  
15   transition between the partial area and the remaining area of the wall surface of  
16   the hollow in the injection mold. This shoulder, permits, as stated above, to  
17   create a straight transition line between the components.

18

19        During hot-runner injection molding, a two-component mixture remains in  
20   the hot runner of the injection mold and may reach during injection of a further  
21   part, the hollow of the injection mold. This would, however, lead to a  
22   contamination of the outer layer of the next injection molded part. It is therefore  
23   proposed that the injection mold includes a hot runner with a by-pass device

1 which permits plasticized material that flows to the hollow to flow into an  
2 overflow. After the first injection molding operation, the by-pass device diverts  
3 oncoming material into the overflow until pure material reaches the runner. Thus,  
4 contaminations can be collected in the overflow for subsequent disposal. Material  
5 collected in the overflow may also further be utilized, for example, to  
6 subsequently purposely seal a gas hole in proximity of the overflow. This may be  
7 implemented by a plunger which conveys melt from the overflow.

8

9 Also proposed is an injection molding device with a plasticizer unit and an  
10 injection unit, which includes at least two secondary extruders arranged between  
11 screw tip and nozzle tip. The use of several secondary extruders permits  
12 sequential introduction of various materials into the injection mold to produce  
13 injection molded parts from most different materials by using the process  
14 according to the invention.

15

16 In addition, an injection molding device is proposed which includes at least  
17 one injection unit having an injection piston by which melt is injected from a melt  
18 compartment, and at least two extruders connected to this melt compartment.  
19 Such an arrangement is capable to injection-mold extremely small workpieces  
20 and to use thereby also very sensitive melts. In particular, it is possible, to charge  
21 the melt compartment with two different melts according to the FIFO (first in, first  
22 out) principle, and to produce in this manner precision components from various  
23 materials or to execute micro injection molding with two different materials.

1        An injection molding device including a main extruder, which includes a  
2    melt compartment from which a nozzle extends via a hot runner, and a  
3    secondary extruder can be operated in an especially simple manner by  
4    transferring melt from the secondary extruder from the melt compartment, when  
5    a second channel, connected to the secondary extruder, is added to the melt  
6    compartment via a control unit which is coupled with the movement of the  
7    secondary extruder.

8

9        Such a coupling may be implemented, for example in a simple manner, by  
10   a rigid connection between control device and secondary extruder. On the other  
11   hand, spring elements may be provided. Moreover, it is also conceivable to  
12   actively operate the control device through control via a pneumatic or hydraulic  
13   mechanism in dependence on the movement of the plasticizer unit.

14

15       The control unit may include an adjustment nozzle which bears upon a  
16   surface, preferably a surface of the secondary extruder, and is secured with a  
17   flange. Such an adjustment nozzle ensures, regardless of other features of the  
18   injection molding device, an extremely simple construction and an extremely  
19   simple replacement of the adjustment nozzle.

20

21       It is also secondary to what extent this nozzle has incorporated therein hot  
22   runners or only feed channels.

23

1        Furthermore, the hot runner may include a pressure-dependent valve. In  
2    such an arrangement, the flow conduction control of the hot runner via the  
3    movement of the secondary extruder may be omitted. Flow conduction is then  
4    controlled pressure-dependent. When melt is transferred from the secondary  
5    extruder to the main extruder at low pressure, such a pressure valve will not yet  
6    respond. Only when the pressure reaches the level during injection molding  
7    through the main extruder will the valve respond. In this manner, the injection  
8    molding process can further be simplified. Such a pressure-dependent valve is  
9    also useable in an advantageous manner, regardless of the remaining features of  
10   the injection molding device.

11  
12        The control unit may, on the other hand, include two partial channels  
13    which open or close the hot runner or feed channel depending on the position of  
14    the control unit. In this manner, a simple control of the control unit is realized in  
15    dependence on the movement of the secondary extruder.

16  
17        In particular, it is possible to so construct one of the partial channels that it  
18    closes the second channel from the secondary extruder to the main extruder  
19    when the secondary extruder has reached its transport position to convey melt to  
20    the main extruder.

21  
22        The control unit may include a partial channel block which accommodates  
23    the partial channels and is guided in a block guide, thereby ensuring a reliable

1 flow control. For example, the above-described adjustment nozzle may be  
2 conceivable as partial channel block. Also other devices, such as plates having  
3 partial channels are conceivable as partial channel block. The partial channel  
4 block may, as described above, be connected with the secondary extruder or  
5 activated independently therefrom.

6

7 A particular simple construction can be implemented when the block guide  
8 accommodates a hot runner. In this manner, the partial channel block may then  
9 be so shifted that, on the one hand, one partial channel opens the hot runner  
10 and, on the other hand, the other partial channel - when the partial channel block  
11 occupies the respective position - opens the pathway between secondary  
12 extruder and hot runner or main extruder.

13

14 Furthermore, an injection molding device is proposed which includes a  
15 main extruder, movable between an injection position and an idle position along  
16 a path, and at least one secondary extruder which includes a control unit,  
17 disposed between the injection position and the idle position, with the control unit  
18 including a channel with an inlet and an outlet and swingable between a charging  
19 position and a release position, wherein in the charging position the inlet points to  
20 the secondary extruder and the outlet points to the main extruder, and wherein in  
21 the release position the pathway for the main extruder is cleared. When rigidly  
22 connecting the inlet with the secondary extruder, the above-stated coupled

1 movement between control unit and secondary extruder is carried out directly.

2 However, other linkages are certainly also conceivable.

3

4 Such a swingable control unit is capable to significantly accelerate and  
5 facilitate the process cycle of the above-described process as well as of other  
6 processes, also regardless of the coupled movement with the secondary  
7 extruder, as a conjoint movement of the secondary extruder or extruders with the  
8 main extruder is no longer required. Rather, the secondary extruders as well as  
9 the control unit are appropriately controlled in dependence on the respective  
10 process stage. When the main extruder is in its idle position, the control unit  
11 occupies its charging position, and the secondary extruder and the main extruder  
12 are connected to the inlet and outlet, respectively, of the control unit. The main  
13 extruder can then be charged by the secondary extruder. After charging, the  
14 secondary extruder is removed from the inlet and the control unit is swung away  
15 to clear the path for the main extruder.

16

17 The above-described arrangement is very compact when the inlet and the  
18 outlet of the control unit define an acute angle relative to one another. Such an  
19 arrangement permits disposition of the control unit immediately in front of a  
20 nozzle plate of the injection molding device, as no additional space is required in  
21 this location for the secondary extruder which projects approximately in a  
22 V-shaped manner from the main extruder. In this way, the pathway to be traveled

1 by the main extruder can be minimized so that the overall time for the injection  
2 molding process can be reduced.

3

4 It will be understood that such a V-shaped disposition of main extruder  
5 and secondary extruder is already advantageous to reduce the required  
6 structural space and thus the pathway to be traveled by the main extruder.

7

8 Furthermore, an injection molding device is proposed including a main  
9 extruder movable between an injection position and an idle position along a path  
10 and traversing with a nozzle in its injection position a nozzle plate and at least a  
11 portion of an adapter plate through an injection opening, and a secondary  
12 extruder which is displaceable between a charging position and a release  
13 position, whereby the path of the injection device is cleared in the release  
14 position and an outlet of the secondary extruder points in the charging position to  
15 the nozzle of the main extruder, with this outlet being disposed in an opening of  
16 the adapter plate which terminates in the injection opening. The opening of the  
17 adapter plate may terminate in the injection opening at an angle of 90°, on the  
18 one hand, or also at an acute angle, on the other hand.

19

20 It is also conceivable, to provide the opening for the secondary extruder in  
21 the nozzle plate. In particular when the adapter plate is absent is this of  
22 advantage, whereby the outlet of the secondary extruder is arranged in the

1 charging position in an opening of the nozzle plate which is aligned with the  
2 injection opening.

3

4 Through the above-described measure, the position which the main  
5 extruder should occupy when being filled with melt by the secondary extruder,  
6 can be shifted to a location immediately proximate of the mold, up into the mold  
7 space. In this manner, the pathway to be traveled by the main extruder is  
8 minimized when being retracted for clearing the outlet, so that the overall time for  
9 the injection process is reduced.

10

11 The secondary extruder may be supported on the outlet side at least in its  
12 charging position by a force applied by the main extruder. This may be implemented  
13 by a guide in the adapter plate or by a lug engaging the adapter plate. In this  
14 way, a correct seat of the main extruder upon the outlet of the secondary  
15 extruder is ensured during charging of the main extruder from the secondary  
16 extruder. Furthermore, there is no need to construct the secondary extruder in a  
17 particularly stable fashion as the above-described support provides for a  
18 sufficient stability. This arrangement also enables in particular to use known  
19 secondary extruders and to provide them with a respective extension piece so  
20 that this embodiment can be realized in a comparably cost-efficient manner.

21

22 Finally, the invention proposes a process for charging a main extruder of  
23 an injection molding device with a melt from a secondary extruder, with the melt

1 being filled in the main extruder through a feed channel in a hot runner which is  
2 connected to the main extruder, on the one hand, and terminates in a mold, on  
3 the other hand, whereby the injection process is so controlled as to leave a sprue  
4 of solidified or solidifying workpiece in the hot runner between mold and the  
5 location where the feed channel terminates in the hot runner, until the main  
6 extruder is filled with the melt.

7

8 This ensures that melt does not flow inadvertently from the secondary  
9 extruder in the direction of the workpiece, but reaches the main extruder. As  
10 soon as the main extruder is accordingly filled, the workpiece can be ejected.

11

12 As a consequence of the above-described process, the use of a valve in  
13 the hot runner can be omitted.

14

15 Advantageously, the sprue extends to immediately the area where the  
16 feed channel terminates in the hot runner.

#### A 17 BRIEF DESCRIPTION OF THE DRAWING

18 The process according to the invention and various exemplified  
19 embodiments for applying the process according to the invention are explained in  
20 more detail with reference to the drawing, in which:

21

22 FIG. 1 is a schematic three-dimensional view of an injection  
23 molding device with mold;

1 FIG. 2 is a sectional cutaway view from FIG. 1;

2

3 FIG. 3 is a schematic sectional view of an alternative embodiment

4 of an injection molding device;

5

6 FIG. 4 is a sectional view through a cap component;

7

8 FIG. 5 is a detail, on an enlarged scale, of FIG. 4;

9

10 FIG. 6 is a sectional view through a further cap component;

11

12 FIG. 7 is a sectional view through a caster component;

13

14 FIG. 8 is a sectional view through a part of the caster component

15 according to FIG. 7, illustrating an embodiment with profile;

16

17 FIG. 9 is a sectional cutaway view of the caster component

18 according to Fig. 7, illustrating an interlocking tire connection;

19

20 FIG. 10 is a sectional cutaway view of the caster component

21 according to Fig. 7, illustrating a gas-filled tire component;

22

23 FIG. 11 is a sectional cutaway view of the caster component

1 according to Fig. 7, illustrating a tire component injected from the direction of the  
2 hub;

3

4 FIG. 12 is a sectional view through a caster component with ball  
5 caster;

6

7 FIG. 13 is a sectional view through a handle;

8

9 FIG. 14 is an illustration of a brush handle;

10

11 FIG. 15 is a sectional view through a housing having an upper part  
12 accommodating a schematically depicted seal and a lower part accommodating a  
13 schematically depicted seal in the cap part and cable feedthrough;

14

15 FIG. 16 is a sectional view through a screwed cable connection;

16

17 FIG. 17 is an illustration of a first embodiment of a bottle closure;

18

19 FIG. 18 is a sectional view through another embodiment of a bottle  
20 closure;

21

22 FIG. 19 is an injection molding device with mold;

23

1       FIG. 20       is a cutaway view from FIG. 19 with a hot runner for hot  
2   runner injection molding;

3

4       FIG. 21       is a schematic illustration of a further injection molding  
5   device;

6

7       FIG. 22       is a perspective illustration of a hot runner block with  
8   adjustment nozzle as control unit;

9

10      FIG. 23       is a sectional view through the adjustment nozzle according  
11   to FIG. 4;

12

13      FIG. 24       is a schematic sectional view through a further control unit;

14

15      FIG. 25       is a schematic illustration of a pivoting nozzle serving as  
16   control unit; and

17

18      FIG. 26       is a schematic illustration of a further injection molding  
19   device.

20      A      DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

21      The injection molding device 1 shown in FIG. 1 includes a nozzle 2 which  
22   is connected to a mold 3. Disposed on the other side of the nozzle are two  
23   secondary extruders 4 and 5 which are placed upon the main extruder 6. Both

1 secondary extruders have feed hoppers 7 and 8, and the main extruder has a  
2 feed hopper 9.

3

4 The mold 3 has a first inlet 10 for plasticized components and a second  
5 inlet 11 for a gas to form a hollow in the injection molded part. In addition, a slide  
6 gate 12 is provided in the mold 3. This slide gate 12 ensures that initially only a  
7 partial area of the wall surface of the hollow in the mold cavity is wetted with  
8 plasticized material, and that a remaining area of the wall surface of the hollow is  
9 only wetted with plasticized material after the slide gate 12 has been drawn.

10 Thus, the cavity of the mold is subdivided into a partial area and a remaining  
11 area, with the remaining area being cleared only after the slide gate 12 has been  
12 drawn.

13

14 FIG. 2 is a sectional view of that part of the injection molding device 1  
15 which is adjacent to the nozzle 2. Adjoining the nozzle 2 is a partial area with a  
16 first plasticized material 13 which is supplied via the feed hopper 7 and the  
17 secondary extruder 4. Then follows a further area which is supplied with a  
18 second plasticized material 14 via the hopper 8 and the secondary extruder 5.  
19 The remaining area of the injection molding device 1 is filled with a third  
20 plasticized material 15 supplied via the funnel 9 and conveyed in the main  
21 extruder 6 by means of a screw 16.

22

23 This enables to sequentially introduce different plasticized materials 13,

1 14, 15, into the mold 3 via the nozzle 2. Preferably, the slide gate 12 is drawn  
2 when changing from one material to the other material, to wet a partial area of  
3 the wall surface of the hollow of the mold with another plasticized material.

4

5 FIG. 3 shows another injection molding device according to the invention.  
6 Here, extruders 21, 22 and 23, 24 are arranged respectively on two sides of a  
7 mold 20. The extruders 21 and 22 feed plasticizeable material to a channel 25  
8 which leads to an opening 26 in the mold 20, and the extruders 23 and 24 feed  
9 plasticized material to a channel 27 which leads to an opening 28 in the mold 20.

10

11 To operate the device, plasticized material can either be initially fed to the  
12 cavity 29 of the mold 20 by the extruder 21, whereupon subsequently another  
13 plasticized material is fed to the cavity 29 by the extruder 22. Alternatively, it is  
14 also possible to initially push plasticized material into extruder 22 by means of  
15 extruder 21, whereupon thereafter the extruder 22 feeds first the plasticized  
16 material originating from extruder 21 into the cavity 29, and subsequently the  
17 extruder 22 conveys readied plasticized material. Of course, the same process  
18 variants are also possible with extruders 23 and 24, although the process  
19 according to the invention can be carried out also solely with the extruders 21  
20 and 22.

21

22 The channel 30 connects the extruders 23 and 24 with the extruders 21  
23 and 22, optionally assisted by an interposed pump 31, so that it is possible to

1 feed four different plasticized materials at the opening 26 or the opening 28 in  
2 succession into the cavity 29 of the mold 20. For sake of clarity, the respectively  
3 required slide gates have not been illustrated. However, the artisan readily  
4 recognizes that the device according to FIG. 3 enables introduction of four  
5 different materials through one opening 26 or 28 into the cavity 29, and that the  
6 device allows various process control methods as a result of installed slide gates.

7

8 Thus, it is, for example, possible to produce with a device according to  
9 FIG. 1 or 3, the cap component 40 shown in Fig. 4. Hereby, a harder material 42  
10 is initially injected at sprue 41 into an injection mold and hardens at the walls of  
11 the mold. Subsequently, a slide gate is drawn to clear an opening in the  
12 areas 43, 44 so that softer material 45 conveyed at sprue 41 flows in the cavity of  
13 the mold up to the space cleared by the slide gate, to form a protruding seal 46.

14

15 Thus, the cap 40 has an envelope of harder material 42 with a subjacent  
16 softer material 45 which is visible only in the marginal area of the cap 40 as  
17 ring-shaped seal 46.

18

19 The sprue area, shown on an enlarged scale in FIG. 5, depicts the harder  
20 plasticized material 42, which hardens at the wall surfaces of the cavity, and the  
21 softer material 45 conveyed at point 41 flows into the mold in the central area  
22 between the wall surfaces of the cavity.

23

1 FIG. 6 shows an alternative embodiment for making a cap by the process  
2 according to the invention. The cap component 50 shown there includes an  
3 arched cap part 51 which is initially injection-molded via a channel 52 from the  
4 direction of the mold inlet 53. Subsequently, the slide gate 54 is so repositioned  
5 that softer material flowing from the opening 53 enters a sealing area 57 cleared  
6 by a slide gate via the channels 55 and 56, to form a ring-shaped seal 58 which  
7 is fixedly secured to the arched cap component 51 of harder material.

8

9 Instead of, or in addition to, the use of a slide gate, a shoulder 59  
10 (compare FIG. 4) may be provided in the mold at the transition point between the  
11 materials, to ensure that the first plasticized material flows only up to this  
12 shoulder, and only the second plasticized material is able to flow beyond this  
13 shoulder. Such a shoulder 59 extends in FIG. 4 transversely to the flow direction,  
14 with a further shoulder 60 arranged in opposite disposition. As a result, the hard  
15 component 42 flows only to the shoulders 59 and 60 and hardens at the margin  
16 of the mold. The subsequently flowing material 45 is no longer retarded by the  
17 shoulders 59 and 60 because the external plasticized material 52 has already  
18 hardened up to the inner edge of the shoulder, so that the subsequently flowing  
19 material 45 flows beyond the shoulder and wets the remaining area of the wall  
20 surface of the hollow.

21

22 FIGS. 7 to 11 show a caster component 70 with various configurations of  
23 a radially outwardly positioned tire 71 to 75. In its basic version, the caster

1 component 70 includes a hub 76 and a radially adjacent tire 71. The mold  
2 provided for injection molding this component has an inlet 77, which leads to a  
3 channel 78, to injection-mold the hub part 76 from a harder material.  
4 Subsequently, a slide gate 79, arranged between the inlet 77 and the channel 78,  
5 is so repositioned that softer material streams via the channel 80 into the radially  
6 outwardly located region of the hub 76, to form a tire 71.

7

8 The modified embodiment according to FIG. 8 provides a profile in the  
9 tire 72. According to FIG. 9, the tire 73 is connected to the hub component 76 by  
10 an interlocking connection 81. FIG. 10 shows the inclusion of a gas into the tire  
11 part to achieve a "balloon effect" by means of an air bubble 82. Lastly, the  
12 exemplified embodiment according to FIG. 11 shows an alternative way of  
13 making the tire by injecting the softer tire component via the channel 78  
14 subsequent to injecting the harder component, so that, like in the case of the cap  
15 component according to FIG. 4, the softer component flows through the center of  
16 the harder component and forms a tire 75 radially on the outside. Also in this  
17 case, either a slide gate, which clears a remaining area of the cavity, or a  
18 shoulder, which inhibits the flow of the first component, can be applied.

19

20 FIG. 12 shows a further caster component, also called a ball caster 90.  
21 Hereby, a hard component is initially injected into the mold via an annular  
22 sprue 91, and subsequently a soft component is injected via the sprues 92  
23 and 93. Like the cap component according to FIG. 4, this component, too, can be

1 made with two different materials injected in succession at sprue 91. The  
2 hardness of the soft component 94 can be adjusted by admixing elastomeric  
3 recycling particles.

4

5 FIG. 13 shows a handle 100 which includes a handle body 101 and a  
6 handle shell 102, with a gas bubble 103 preferably provided in the handle body.  
7 The handle body is made from a harder material through injection via the  
8 inlet 104 and the handle shell is made from a foamed material through injection  
9 via the inlet 105. Optionally, soft components, for example for door handles or as  
10 handbrake levers as well as for pedals, can be injected from inside.

11

12 FIG. 14 shows a brush handle 110 which is made by injecting initially a  
13 soft component 111 via the sprue 112 and subsequently by injecting a hard  
14 component 114 via the sprue 113. Of course, the various materials 111 and 114,  
15 like in the other exemplified embodiments, may also have, additionally or  
16 alternatively, various colors or include plasticizable materials of various  
17 properties in some other way. In particular, any kind of handles, flatware, for  
18 example for camping with soft handle, designer flatware, toothbrushes or tool  
19 handles, may be made through this process. Through combination with a gas  
20 bubble, also two-component hollow parts can, for example, be made, especially  
21 handles or the like.

22

23 The manufacture of a housing 120, as shown in FIG. 15, is a further

1 frequent application of the process described herein. As shown by the schematic  
2 illustration of FIG. 15, this housing has in the upper part of the drawing a  
3 seal 121 which is located in the housing part, and in the lower part of the figure a  
4 seal 123 which is arranged in a matching cap part 122 and interacts with a  
5 complementarily shaped counterpart 124 in the housing 120. This housing can  
6 be made analogous to the previously described cap according to the process  
7 shown in FIGS. 4 and 6. An advantageous configuration of the housing shows a  
8 cable feedthrough 125 which has a ring 126 of a softer plastic material.

9

10 FIG. 16 shows a screwed cable connection 130 with a claw-shaped strain  
11 relief 131 and a seal 132. In this embodiment, a harder component 134 is initially  
12 injected through mold inlet 133 to form the body of the screwed cable  
13 connection 130 and the claws of the strain relief 131. Subsequently, the slide  
14 gate 135 is so repositioned that in addition to the central channel 136, two further  
15 channels 137 and 138 are cleared so that subsequently flowing softer material  
16 can flow into a region cleared by a slide gate (not shown), to form the seal 132.  
17 At the same time, a partial stream of the softer material in the central  
18 channel 136 flows to the strain relief 131 to form also there a body 139 of softer  
19 material.

20

21 While in the upper part of FIG. 16, the claws of the strain relief 131 are  
22 shown in their uncompressed state, the lower part of FIG. 16 shows how the  
23 claws of the strain relief 131 are compressed by means of a screwed-on

1 clamping nut 140.

2

3 It will be appreciated that a number of electric articles or auxiliary electric  
4 articles can be made in this fashion.

5

6 FIG. 17 shows a bottle closure 150 as a further embodiment. This bottle  
7 closure is made from a harder component 151, which forms the base body, and a  
8 softer component 152, which protrudes in the form of a ring in a certain region  
9 and acts as a seal. A gas bubble 153 is provided within the harder  
10 component 151 to save material and to attain a higher flexibility of the bottle  
11 closure. The closure may also be constructed of solid configuration.

12

13 FIG. 18 shows a further bottle closure 160. This bottle closure includes a  
14 hard inner part 161 which is surrounded by a softer material 162, whereby it is  
15 also possible to reverse the type of materials. The inner part 161 includes  
16 ribs 165 which extend, preferably, from a central axis 163 to a ring body 164.

17

18 The process according to the invention can be used for numerous further  
19 applications such as wheels made of hard and soft components, to children's  
20 toys made of differently colored components, joints of hard and soft components  
21 up to caps having opaque and transparent zones. Further examples include:  
22 screwdriver handles, hangers with anti-slip edges, shock absorbers, buffers,  
23 silent blocs, furniture hardware, buttons or shoe soles. Also parts can, for

1 example, be made of which at least one material component are antistick or  
2 hydrophobic. This component is then quasi self-cleaning and could be used, for  
3 example, for shoe soles, in particular shoe soles with cleats. Important areas of  
4 application include moreover transport belts, transport drums and transport  
5 rollers.

6

7 FIGS. 19 and 20 show the use of a mold with a special hot runner. When  
8 injecting two different materials 170, 171 with an injection unit 172 into a  
9 mold 173, several materials 170, 171 are fed in succession into the mold 173.  
10 Thereby, an outer ring made from the first component 170 forms in the hot runner  
11 and accommodates as a core the further component 172. After conclusion of the  
12 injection process with the component 171, it is however necessary to again feed  
13 new component 170 which, normally, pushes the remaining residue of the  
14 second component 171 in the hot runner 174 as contamination into the cavity.

15

16 FIG. 20 shows an overflow 175 and a slide gate 176 in the hot runner 174  
17 to avoid such contamination. The slide gate 176 enables to press the remainder  
18 of the second component 171 with subsequently fed first component 170 into the  
19 overflow 175 and to clear the cavity 177 only when first material is again provided  
20 at the slide gate 176. Thus, the use of a sprue rod is no longer necessary.

21

22 FIG. 21 illustrates an injection molding device which includes an injection  
23 unit with an injection piston 201 for injecting melt from a melt compartment 202.

1 Two extruders 203 and 204 fill the melt compartment 202 with melt. The injection  
2 piston 201 is driven by an injection cylinder 205. Particularly fine precision  
3 components can be made with such an arrangement. This arrangement is  
4 especially suitable for micro injection molding with two different starting materials.

5

6 The connection between the extruders 203 and 204 may be ensured, on  
7 the one hand, via valves. It is, however, also possible to ensure a desired filling  
8 of the melt compartment 202 through appropriate selection and control of the  
9 melt streams flowing during filling.

10

11 FIG. 22 shows a hot runner block 230 which interacts with a particular  
12 adjustment nozzle 231. This adjustment nozzle 231 is secured to a secondary  
13 extruder 263 by a flange. In this manner, the adjustment nozzle 231 can very  
14 easily be positioned. When adjusting the adjustment nozzle, in particular the  
15 distance of the nozzle end will not change, as is the case with threadably  
16 engaged conventional adjustment nozzles.

17

18 The hot runner block 230 has a through channel 232 and a round central  
19 opening 233 which intersects the channel 232 for receiving the adjustment  
20 nozzle 231. This nozzle 231 has a bore 234 which extends transversely to the  
21 nozzle axis, with the bore corresponding to the diameter of the channel 232 and  
22 aligned with the channel 232 through counterboring the adjustment nozzle in the  
23 opening 233 of the hot runner block 230.

1        Above the bore 234, the adjustment nozzle 231 is provided with a  
2    L-shaped bore 235 which should also be aligned with the channel 232 and then  
3    connects the secondary extruder 236 with the channel 232 to convey  
4    plasticizeable material from the secondary extruder 236 through the L-shaped  
5    channel 235 into the channel 232.

6

7        The channel 232 is further in communication with a main extruder 237.

8

9        The adjustment nozzle 231 thus operates as control unit to provide a flow  
10   path between the main extruder 237 and the secondary extruder 236 and  
11   workpiece. It will be understood that such an adjustment nozzle 231 is also  
12   advantageous for other control units.

13

14       Furthermore, the flange-mounting can advantageously be used,  
15   regardless of other features of the adjustment nozzle 231, for any kind of nozzles  
16   which should be precisely adjusted.

17

18       Another control unit is shown in FIG. 24 and includes a hot runner 241 for  
19   conducting melt from a main extruder to a mold nest (as indicated by the arrow  
20   246). Branching off from this hot runner 241 is a partial channel 242 which can  
21   be connected, depending on need, with a feed channel 243 of a secondary  
22   extruder. This is attained by moving a sleeve, which surrounds the hot runner  
23   and accommodates the feed channel 243, along the hot runner 241. Through this

1 movement, the feed channel 243 may selectively be aligned with the partial  
2 channel 242.

3

4 To prevent melt from migrating in the direction of the mold nest during  
5 filling of the main extruder by the secondary extruder, a pressure valve is  
6 positioned in the hot runner 241 immediately behind the location where the  
7 partial channel 242 branches off. The pressure valve is so dimensioned as to  
8 close at pressure applied by the secondary extruder and to open at a pressure  
9 applied by the main extruder.

10

11 Instead of the pressure valve 245, the injection molding process may also  
12 be controlled in such a manner that a sprue extends from the mold nest and  
13 remains in the hot runner 241 which extends to this previously described  
14 location. The sprue ensures that the melt does not flow in the direction of the  
15 mold nest. Only when the main extruder is filled in a desired manner will the  
16 workpiece be ejected with the sprue so that the hot runner 241 is cleared again.

17

18 A further control unit is shown in FIG. 25 and provided in the form of a  
19 pivoting nozzle 250 having an inlet 251 and an outlet 252 which are  
20 interconnected by a channel 253. The pivoting nozzle 250 is swingable about an  
21 axis 254 and secured by means of a fastening flange 255 to a tie rod 246 of the  
22 main extruder 257.

23

1        In the charging position (shown in FIG. 25), the inlet 252 points to the  
2    injection nozzle of the main extruder 257, while the inlet 251 points to a  
3    secondary extruder 258. In this position, the main extruder 257 and the  
4    secondary extruder 258 can be brought into contact with the inlet 251 and the  
5    outlet 252, respectively, and melt can be filled into the main extruder 257.

6

7        After charging the main extruder in a desired manner, the pivoting  
8    nozzle 250 is tilted upwards in the direction of the arrow, so that the path for the  
9    main extruder 257 is cleared and the latter can travel into its injection position.

10

11        According to another embodiment, the secondary extruder 258 may be  
12    securely fixed to the pivoting nozzle 250 and swung in unison with the latter.

13

14        As can be seen from FIGS. 24 and 25, the secondary extruder and the  
15    main extruder are arranged at an acute angle relative to one another or arranged  
16    in a V-shaped disposition. This enables a positioning of the control unit 240  
17    and 250, respectively, in immediate proximity of the workpiece, so that the  
18    distances to be traveled by the main extruder can be minimized. As a result, the  
19    injection process can be carried out at increased speed.

20

21        FIG. 26 depicts a further possibility of increasing the working speed of an  
22    injection device which includes a main extruder having a nozzle 301 traversing a  
23    nozzle plate 302 as well as a portion of an adapter plate 303 through an injection

1 opening 304 to reach its injection position. The nozzle plate 302 denotes hereby  
2 an end of the mold space on the main extruder side, whereas the adapter  
3 plate 303 is a part arranged on the nozzle plate 302 for conforming to various  
4 molds or the like.

5

6        Provided in the adapter plate 303 is an opening 305 which terminates in  
7 the injection opening 304. Extending through the opening 305 is an extension  
8 piece 306 which leads from a secondary extruder to an outlet 307. Through  
9 moving the secondary extruder, the outlet 307 can be aligned with the injection  
10 opening 304 so that the main extruder can be charged from the secondary  
11 extruder when the nozzle 301 bears against the outlet 307.

12

13        For reasons of stability, the secondary extruder has an end which faces  
14 away from the outlet 307 and includes a lug 308 for engagement in a respective  
15 recess 309 of the adapter plate 303. For cleaning purposes, the recess 309 may  
16 be extended out of the adapter plate 303 so as to allow a discharge of excess  
17 melt.

18

19        As immediately evident, such an arrangement results in a minimized path  
20 to be traveled by the nozzle 301, when an adapter plate is provided in the mold  
21 space.

22

1 Standard components may be used as extension piece 306 so that this  
2 embodiment is further especially cost-efficient. To prevent an escape of melt,  
3 needle shut-offs may be provided at the outlet 307 and the nozzle 301.

4

5 Through the above-described arrangements and processes, especially  
6 pipes with a connection sleeve, hoses with fastening elements, brackets or plug  
7 connectors, pipes with flexible intermediate pieces or clutch pedals or other  
8 pedals, including lever gears and bar linkages with a soft element at the pedal  
9 pad, can also be made.

10

11 All this can be carried out in a single injection operation, thus significantly  
12 reducing the process time.

13

14 In practical application, the changeover from a first component to a further  
15 component, and, optionally, to a third, fourth etc. component, requires  
16 considerable experience, because the timing has to be exactly right. In order to  
17 ascertain the correct moment, sensors can be provided in the injection molding  
18 device and in particular in the mold or in an ejection bore for monitoring through  
19 pressure, temperature or ultrasound the filling of the cavity with the various  
20 plasticized materials. For better process monitoring, a pause can be introduced  
21 between the supply of different plasticized materials. In addition, the control of  
22 movement of the screw, i.e. the distance of material conveyed by the screw, can  
23 be used directly for controlling the slide gates. Instead of the distance, it is also

- 1 possible to measure the time elapsed from commencement of the injection
- 2 procedure, to determine the correct moment for control of the slide gate. Finally,
- 3 it is also possible to use the interior pressure of the mold as a parameter for the
- 4 slide gate control.